Beetle diversity in forest and pastoral areas, Whangamata, Coromandel Peninsula

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Abstract

Malaise traps were set out for four weeks in December 1997 to compare the beetle populations in kanuka bush, fern bush, a 25 year old mature radiata pine stand, a 6 year old radiata pine plantation, nearby hayfields, grassed foreshore areas and on coastal sand dunes. Greater numbers of beetle species were collected at the forested sites than at the pastoral, urban and sand dune sites. The greatest number of beetle species was collected in the mature radiata pine stand, which had a well developed understorey of shade tolerant native shrub species. The beetle faunas at forested locations had higher degrees of endemism. Habitats maintained by constant human activity had more adventive species. The most common species in the grassland habitats were the lucerne weevil *Sitona discoideus* and the click beetle *Conoderus exsul*, both adventive species. The more numerous species in the forested habitats included the bark mould beetle *Salpingus bilunatus*, the elaterid *Panspoeus guttatus* and the fungus weevil *Liromus pardalis*, all native species.

Keywords: beetle diversity - malaise trapping - native bush - sand dunes - grasslands - pine plantations.

Introduction

Recent studies of the perceptions of local residents and visitors to the Whangamata area, Coromandel Peninsula, of the naturalness of local landscapes showed that areas of native forest and beach areas (without houses) were deemed more natural than modified landscapes such as fields, plantations, residential areas and urban shopping areas (Fairweather & Swaffield 1999). How does this perception of naturalness represent the biological realities of the plant and animal species that currently inhabit this anthropogenically modified landscape?

Early settler records from the 18th century record that a tall native tree forest once extended to the coastline in this part of the Coromandel Peninsula. Kauri (*Agathis australis*) dominated the hills, whereas coastal swampy areas were

dominated by kahikatea (*Dacrycarpus dacrydioides*). After waves of colonisation by Polynesians around 600 years BP and Europeans 200 years BP, the land showed the effects of major resource extraction, especially of timber and kauri gum. Adams (1883) reported that the area was the most ruined and disfigured part of New Zealand at that time. Against this background, European settlers set about establishing an agricultural economy based on cattle and sheep farming at the beginning of the 20th century. The trials and tribulations of this period are well reported by Williamson (1988). Forests of exotic pine species were planted and the mosaic seen today is a reflection of those species that established satisfactorily to form present day plantations. The area around Whangamata consists of protected shorelines with extensive sand dunes behind beaches exposed to the Pacific Ocean and an urban centre that serves a small resident population of 5,000 that swells to 40,000 during summer. Farmers maintain pastoral activities on the coastal plains and in the major valleys. Radiata pine (*Pinus radiata*) plantations have been established on the inland hills and recolonising native bush has been retained on private land and in places such as the Wentworth Valley Reserve.

The objectives of the present study were to evaluate diversity and degree of endemism of beetles (Coleoptera) in a range of habitats on the sand dunes of Wharekawa and the Otahu River estuary (Figure 1), the grass walkways between beachfront properties at Whangamata, pastures, a young radiata pine plantation, a mature radiata pine stand, a fern-dominated bush area and a kanuka-dominated bush reserve. The Coleoptera is the largest of the insect orders and is well represented across all trophic levels. In New Zealand there are at least 5235 native species of beetles in 82 families as assessed by Klimaszewski (1997), plus an additional 354 introduced species.

Methods

Pairs of standard Malaise traps (Townes 1972), with 70% isopropyl alcohol in the collecting jars, were set out for one month on 5 December 1997 at each of eight collecting sites in the Whangamata area (Figure 1). Traps were oriented with the collecting jars towards the north. Trapping for four weeks in December was recommended by Hutcheson & Kimberley (1999) after an earlier intensive season-long assessment of Malaise trapping for beetles (Hutcheson 1990) showed that collections during this period gave the best discrimination among habitats.

To define the composition of vegetation around each trapping location, 500 m^2 plots were set up in collaboration with C. E. Ecroyd (Curator, National Forestry Herbarium, Scion, PB 3020, Rotorua, New Zealand) following the procedures of Allen and McLennan (1983) as modified with respect to cover scores by Leathwick (1987). A full species list of plants for each area is available from the authors on request.

Trapping sites

Site 1: The Wharekawa Harbour sand dunes

The dunes have been planted with radiata pine and maritime pine (*Pinus pinaster*). The two Malaise traps were set up 50 m apart in leeward hollows of the front dunes, and were partially protected from on-shore winds by the

pines. The major ground cover was harestail (*Lagurus ovata*). Other species present were pohuhue (*Muehlenbeckia complexa*), spinifex (*Spinifex sericeus*), knotty clubrush (*Isolepis nodosa*) and the sand dune moss (*Thuidium furfurosum*).

Site 2: The Otahu River sand dunes

Several species have been planted throughout this heavily used area in an effort to stabilize the sand dunes. The dunes provide access to the ocean beach as well as protected waters at the mouth of the Otahu River. Trap 2A was set out in a well grassed area with a small pohutukawa (*Metrosideros excelsa*) to the south. The major grasses present were cocksfoot (*Dactylis glomerata*), tall fescue (*Festuca arundinacea*), knotty clubrush, Indian doad (*Cynodon dactylon*) and kikuyu grass (*Pennisteum clandestinum*). Trap 2B was set out in an area that was dominated by spinifex, catsear (*Hypocheris radicata*), knotty clubrush and lupin (*Lupinus arboreus*). Sand coprosma (*Coproma acerosa*), pohuhue and shore bindweed (*Calystegia soldanella*) trailed through the areas around both traps.

Site 3: The grassed walkways that provide public access to the main Whangamata beach from Pohutukawa Drive

These sites were very dry in the middle of summer. Traps 3A and 3B were anchored on the southern side of two walkways. Kikuyu grass was the dominant species

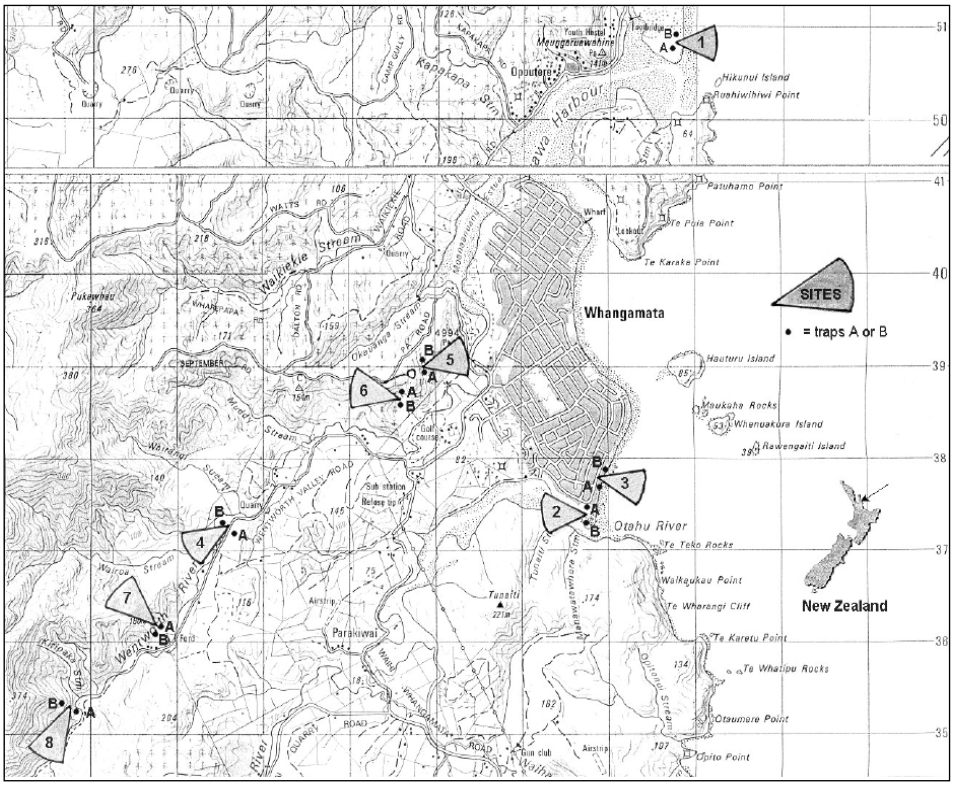

Figure 1. Locations of the eight collecting sites in the Whangamata area where pairs of Malaise traps were set out in December 1997. Note the disjunction between 41″ and 50″ parallels. The town of Whangamata is located at 37° 13′ 40″ S, 175° 52′ 50″ E.

at each site and each trap had a coast Banksia tree (*Banksia integrifolia*) close by. Bare ground made up 30% and 20% of the area at Traps 3A and 3B, respectively. Some paspalum (*Paspalum dilatatum*) grew close to the fences, but did not spread over the walkways.

Site 4: Pastures in the Wentworth Valley locked up for hay production

Trap 4A was set out in a paddock on the south side of Wentworth Valley Road, whereas Trap 4B was in a paddock on the north side of the road. The Wentworth River ran through the north paddock. The main grasses around Trap 4A were sweet vernal (*Anthoxanthum odoratum*) and brown top (*Agrostis capillaris*). Sweet vernal was also the major pasture grass around Trap 4B with Yorkshire fog (*Holcus lanatus*), lotus (*Lotus pedunculatus*), red clover (*Trifolium pretense*), and paspalum species also present.

Site 5: A 6 year old second growth radiata pine plantation on an east facing slope 25 m below the Pa Road Lookout

Purple pampus grass (*Cortaderia jubata*) was clearly visible at the edge of the plantation and also scattered throughout the stand along with tutu (*Coriaria arborea*). Bare soil made up 40% and bracken (*Pteridium esculentum*), was widely distributed at low density. Silver fern (*Cyathea dealbata*), was moderately abundant throughout the stand. Traps 5A and 5B were located 100 m apart on the same contour 25 m below the edge of the Lookout parking lot.

Site 6: A ridge top mature radiata pine plantation, 24 years old, to the south of the Pa Road Look Out

The wider spacing of trees in this mature radiata pine stand allowed enough light through to the forest floor to enable shade tolerant native species to survive. We tabulated 21 native species around trap 6A and 28 species around trap 6B. Among these were mapou (*Myrsine australis*), karamu (*Coprosma robusta*), mamaku (*Cyathea medullaris*), rangiora (*Brachyglottis repanda*), silver fern, five finger (*Pseudopanax arboreus*), dwarf ti (*Cordyline banksii*) and bracken.

Site 7: Fern Bush

Beyond the kanuka (*Kunzea ericoides*) and mamaku edge of this fern-rich site was an emergent vegetation of rewarewa (*Knightia excelsa*) and towai (*Weinmannia silvicola*). Silver fern was the dominant pteridophyte. Rangiora, kawakawa (*Macropiper excelsum*), five finger and mahoe (*Melicytis ramiflorus*), were present in height tier 4 (2-5 m). We tabulated 18 and 29 plant species around traps 7A and 7B, respectively. Several epiphytes were also recorded. Traps were located at least 10 m within this bush remnant.

Site 8: The kanuka-dominated native bush near the start of the Wentworth Valley Reserve walking track

Trap 8A was set out in an area rich in silver fern, mapou and nikau (*Rhopalostylis sapida*). Wheki (*Dicksonia squarossa*) was also common in the understorey. We recorded 30 species at this location including four epiphytes. Trap 8B was in an area dominated by towai and mapou; supplejack *Rhipogonum scandens*) trailed throughout the site. Major understorey species included hangehange (*Geniostoma rupestre*), kanano (*Coprosma grandifolia*) and rangiora. We recorded 35 plants in this area including three epiphytes: supplejack, white climbing rata (*Metrosideros diffusa*) and mangemange (*Lycodium articulatum*).

Beetle collection

Malaise traps were cleared on 12, 19 and 26 December 1997 and 2 January 1998 (weeks 49 – 52). Beetles were separated from the collections and identified to species or RTUs (recognized taxonomic units) as accurately as possible. Identifications were made by comparing specimens with named beetles in the Coleoptera collection at Ensis that in turn had been verified by Hutcheson (1996) against the New Zealand Arthropod Collection held at Landcare Research, Mt. Albert, Auckland (binomial and sp-0X designations). Species apparently unique to this study were labelled wv-0X. The current classification of New Zealand Coleoptera families by Klimaszweski & Watt (1997) was followed. Assignment of endemic or adventive status was made with reference to Kuschel (1990).

Data analysis

Alpha diversity of Coleoptera was evaluated by comparing the average number of species captured at each site on a weekly basis in a one way ANOVA followed by Tukey's Test in SIGMASTAT (1995). A box plot graph is presented for these data. Numbers of native and adventive species were tabulated. In addition, the Shannon-Weiner Index (Vandermeer 1981) was computed for each site based on the total catch in the two traps over four weeks. Our experimental design enabled two-way indicator species analysis (TWINSPAN) to be used to assess the consistency of species caught at each site. Beetle numbers were transformed to abundance classes (AC 1-5) using classes defined by cut levels of 1, 2, 5, 10 and 20 specimens, the defaults used in the TWINSPAN programme (Hill 1979) and adopted by Hutcheson & Kimberley (1999). Data for all beetles identified to species, or with confirmed RTU status, were included in the TWINSPAN analysis carried out with the PC-ORD package (McCune & Mefford 1997). The TWINSPAN programme characterises groups of sites according to the species that prevail on each side of a dichotomy (Jongman *et al.* 1995) and continues until all required divisions have been made.

Results

A total of 3963 beetles was collected during the sampling period, 130 species in the grass areas (Sites 1-4) and 217 species in the forested areas (Sites 5-8). Forty seven and 77 of the species were taken as single specimens in each area, respectively. More beetles were caught in the grass areas than in the forested areas; 2511 and 1452 individuals, respectively. The grass area catches were dominated by the adventive lucerne weevil *Sitona discoideus* (1009 specimens), the click beetle *Conoderus exsul* (416) and the mildew beetle *Bicavia* sp-01 (378). In the forested areas, the more numerous species included the bark mould beetle *Saplingus bilunata* (83), the elaterid *Panspoeus guttatus* (82) and the fungus weevil *Liromus pardalis* (67). A full listing of species caught and an indication of those species recorded as single specimens are given in Appendix I.

More adventive species were trapped at the highly modified grass sites than in forest. A lower proportion of adventive species was recorded in the forested areas, although the status of several species is undetermined at this time (Table 1). The Shannon-Weiner Index, which is influenced by both the number of species and their evenness, was higher in forested areas than grass areas (Table 1). The mean

number of species at the mature radiata pine site (Site 6) was significantly higher than at any other site (Figure 2), whereas lowest numbers of species were taken in the dunes (Sites 1, 2).

The first division of TWINSPAN (not shown) separated the grass sites (Sites 1-4) from the forested sites (Sites 5-8). Sites 1-4 were characterized by the click beetle *C. exsul* (AC2 = abundance class 2) and root weevil *S. discoideus* (AC4). The forested areas were characterised by the hooded beetle *Arthrolips oblongus* (AC1) and the longhorn beetle *Oemona hirta* (AC1). The

Table 1. Numbers of species, endemicity and diversity of the beetle fauna collected in Malaise traps in the Whangamata area in summer 1997-98. E = endemic, A = adventive, ? = unknown status at time of writing.

	Number of Species					Shannon-Weiner Index
Site	E	A	?	Total	% E	
1. Wharekawa sand dunes	17	6	8	33	51.5	1.901
2. Otahu River sand dunes	16	12	15	44	36.4	1.771
3. Grass walkways	18	15	39	67	26.9	1.822
4. Pasture	25	10	27	62	40.3	1.763
5. Young radiata pine (6 years)	41	2	16	58	70.7	3.471
6. Mature radiata pine (24 years)	71	8	50	124	57.3	3.579
7. Fern bush	52	2	34	88	59.1	3.357
8. Kanuka bush	48	2	26	77	62.3	3.573

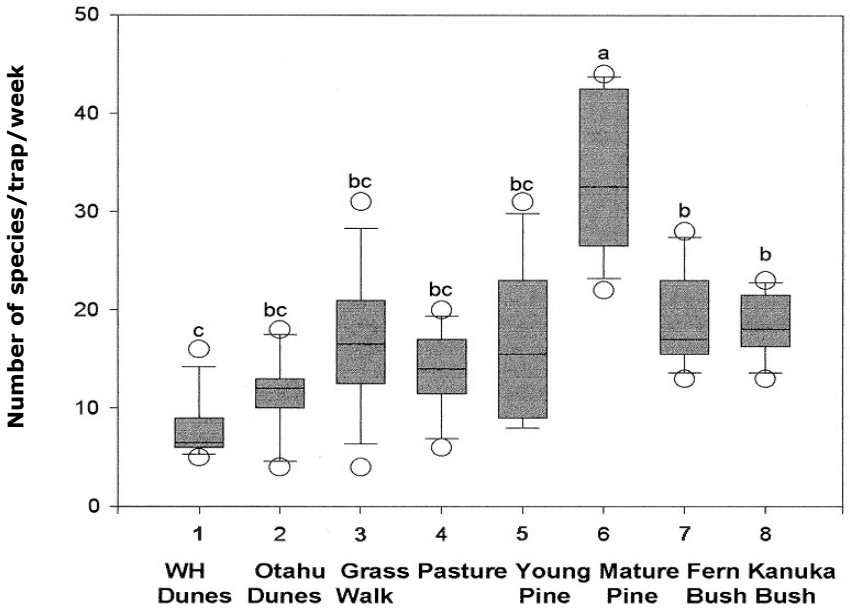

Figure 2: Box plot showing the number of beetle species caught / trap / week at 8 sites differing in vegetation cover. Shaded rectangles show 75 and 25 percentiles surrounding the mean, vertical bars show the 95 and 5 percentiles with outliers indicated as open circles. Superscript letters indicate significant differences among sites (Tukey's Test, $P<0.05$).

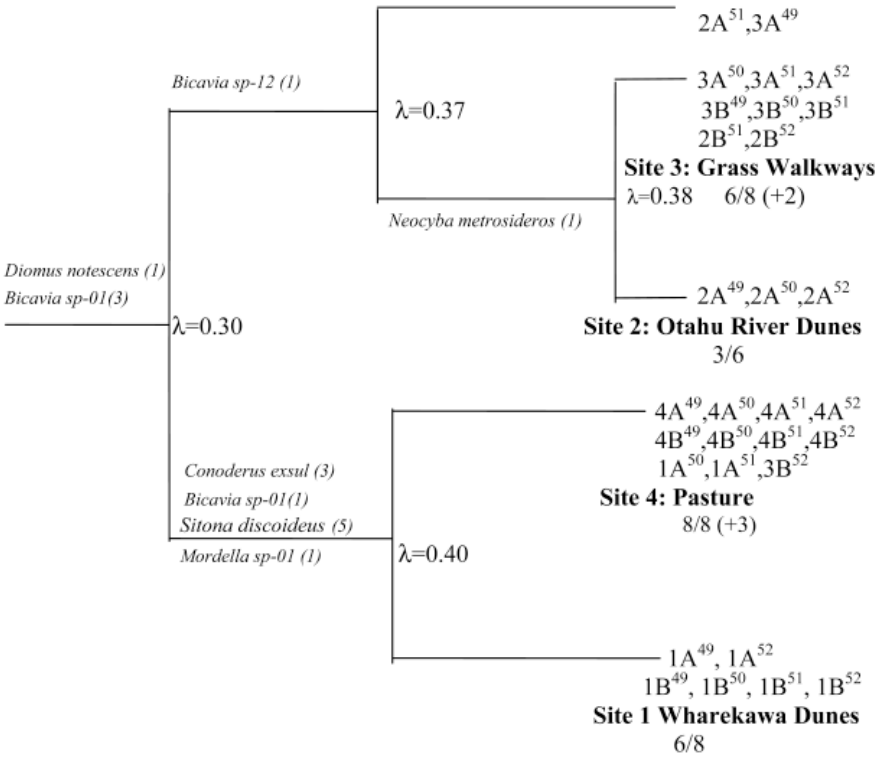

Figure 3. Dichotomies derived from the TWINSPAN analysis of weekly collections from the sand dune and grass area data sets that included Sites 1-4. Traps within sites are designated A and B and collection weeks by the superscripts 49-52. Indicator species are shown with their abundance classes in parentheses. Eigenvalues (λ) are given for each division. Fractions indicate the number of collections that grouped according to site. Numbers of "incorrectly grouped" collections are given in parentheses.

eigenvalue for the first division (0.71) indicated that 71% of the variance was accounted for by these four species. The subsequent two sets of divisions grouped trap catches to trap sites to a large extent (Figures 3 and 4).

The Australian aphidiophagus coccinellid *Diomus notescens* (AC1) and the native mildew beetle *Bicavia* sp-01 (AC3) were additional indicator species for the grass walkways (Site 3). Trap 2A was further characterised by the brentid weevil *Neocyba metrosideros* (AC1), which was probably active in the nearby pohutukawa tree, a known host recorded in the vegetation survey. Larger numbers of *S. discoideus* (AC5) and the predatory elaterid *C. exsul* (AC3) were consistently taken in the pasture area (Site 4) along with *Bicavia* sp-01 (AC1). The unique indicator species for the Wharekawa sand dunes (Site 1) was the pintail beetle *Mordella* sp-01 (AC1). Of the 30 catches collected from the sand dune/grass sites, 23 (77%) were grouped by site (Figure 3).

The indicator species that characterised kanuka bush (Site 8) included the endemic

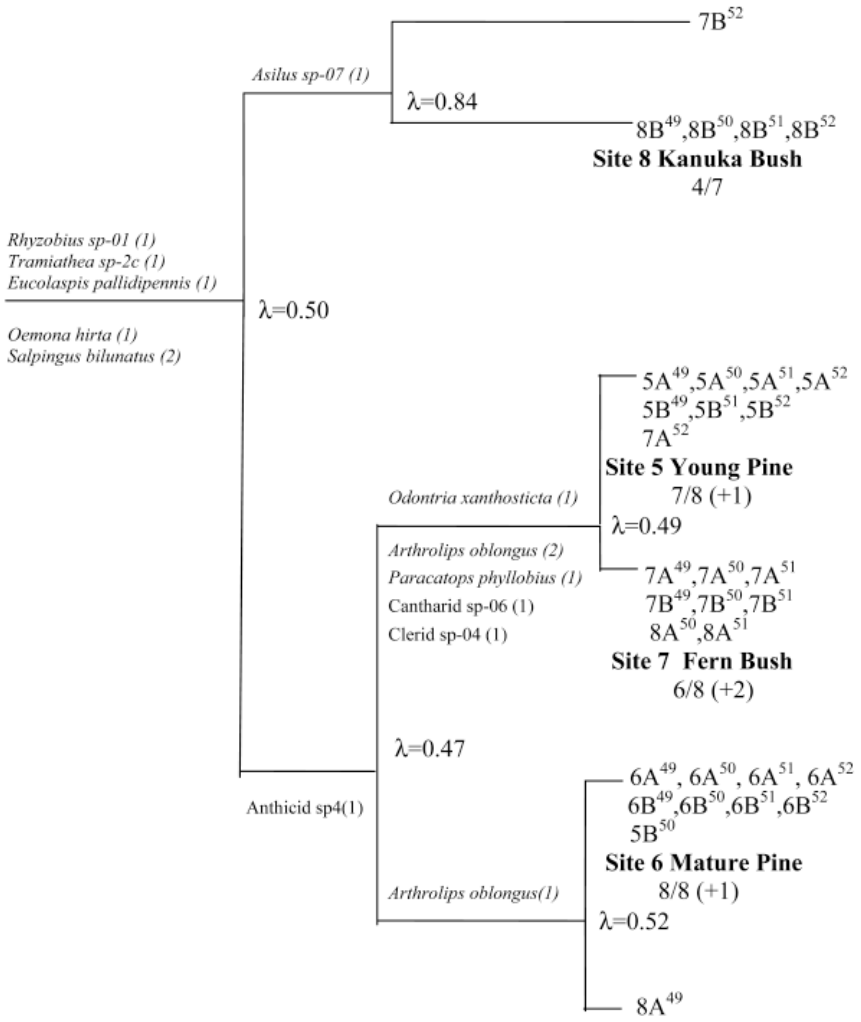

Figure 4. Dichotomies derived from the TWINSPAN analysis weekly collections from the pine and native bush data set that included Sites 5-8. Enumeration of collections as in Figure 3.

chysomelid *Eucolaspis pallidipennis* (AC1), the staphylinid *Tramiathea* sp-2c (AC1) and the coccinellid *Rhyzobius* sp-01 (AC1). Absence of the soldier beetle *Asilus* sp-07 also characterised this site. The cerambycid *Oemona hirta* (AC1) and the bark mould beetle *Salpingus bilunatus* (AC2), both endemic species, characterised the other forested areas. An additional indicator species for young pine (Site 5) was the endemic scarabid *Odontria xanthosticta* (AC1), while fern bush (Site 7) was further characterised by *A. oblongus* (AC2), the leiodid *Paracatops phyllobius* (AC1), cantharid sp-06 (AC1) and clerid sp-04 (AC1). Mature pine (Site 6) was characterised by the presence of anthicid sp-04 (AC1), an ant beetle (Corticariidae), and *A. oblongus* (AC1). Of the 31 samples collected at forested sites, 25 (81%) were grouped by site (Figure 4).

Discussion

Results of our survey at Whangamata show that while there were larger numbers of beetles in grassland-dominated ecosystems than forests, fewer beetle species were taken. Furthermore, beetle diversity was much greater in the forested ecosystem collections than at the grass and sand dune sites. The significantly higher number of species trapped under the mature pine canopy appeared to be related to the greater abundance of shade tolerant native species that had established there. Accounts of plant richness under *Pinus radiata* of several ages, reported since our survey was undertaken, have shown that sub-canopy development of shade tolerant native species is a normal occurrence, and that both richness and cover of indigenous plants is highest in mature pine stands (Brockerhoff *et al*. 2003). The high beetle diversity found in second growth pine stands in our study indicates it is possible to maintain beetle populations in plantations, possibly because fern species in particular, survive the harvesting process (Pawson 2004). Our findings also support the proposition of Norton (1998) that with careful management, plantation forests can contribute to the conservation of indigenous biodiversity by providing habitat for indigenous flora and fauna.

Does the perception of naturalness match the level of biodiversity of native species in an environment? People accept that man-made development such as urban housing and shopping malls are not natural landscape features. Further, they also perceive hay fields and rows of plantation trees as less than "natural". Early New Zealand farmers converted native bush into pasture as a matter of survival and introduced exotic but proven species of pasture grasses to feed their livestock. It is ironic to recall that acclimatization societies existed in New Zealand for the purpose of vigorously introducing a wide range of plants, animals, fish and birds for economic, aesthetic and recreational reasons (Wynn 1997). In addition to their deliberate introductions of plant materials, associated insect species undoubtedly were introduced, incidentally, and today would be described as invasive species. With regard to the two dominant and adventive beetle species found at the pasture sites, *C. exsul* was first collected in New Zealand in 1875 and is thought to be of Australian origin, while *S. discoideus* was first reported in 1975 and is of Palearctic origin (Kuschel 1990). These species have successfully colonized grassland habitats, and we support the view that they are correlates of human disturbance (Didham *et al.* 2005).

Our survey also suggests that multilayered canopies can greatly enhance the development of native shrub species and their associated beetle fauna. The 24 year old pine plantations are already supporting a rich diversity of indigenous species and so help to maintain the native New Zealand flora and fauna. Forest managers need to recognize the benefit of retaining some of these areas when developing plans for harvesting.

Acknowledgments

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hay fields along the Wentworth Valley Road; C. White and G. Spencer of the Hauraki District Office of Carter Holt Harvey Ltd. For access to the young pine and mature pine plantations near the Pa Road Lookout; and the Bushland Park Lodge and Wentworth Valley Lodge for access to the fern bush behind their estates at the head of the Wentworth Valley Road. We thank S. Kilvert for sharing his local knowledge that enabled us to select the study sites, and also B. Hock, J. Hutcheson and M. Winterbourn for their guidance and constructive comments.

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Appendix I. Beetle species by family found in 8 locations in sand dune / grass and forest areas, Whangamata, Coromandel Peninsula. Species designated with sp-01 type numbers are reference to RTUs in the New Zealand Arthropod Collection. Species designated with wv-01 type designations were RTUs that could only be identified to family or genus given the time and resources available for this study. x = a single specimen captured at this site in the two Malaise traps during the 4 weeks of the study; X = >1.

	Sand Dunes / Grass Areas					Forest Settings				
Study Site	1	2	3	4	#	5	6	7	8	#
Aderidae										
Aderid wv-01	x			X	4		X	x	X	12
Aderid wv-02					0			x		1
Anobiidae										
Anobium punctatum				X	13					0
Anobium sp1			x		1					0
Ptinus speciosus					0		X		X	6
Anthicidae										
Anthicid sp-04					0	x	X		X	31
Cotes gourlayi					0		X		x	4
Anthribidae										
Anthribid wv-01					0				x	1
Anthribid wv-02					0		x			1
Cacephatus huttoni					0		X	x		6
Euciodes suturalis	X	X	x	X	8					0
Hoplorhaphus spinifer					0	x			X	3
Isanthribus proximus					0			x		1
Liromus pardalis				x	1		X		X	67
Phymatus heterea					0	X	X	x	X	19
Phymatus phymatodes					0		X			4
Pleosporius bullatus					0	x		x		2
Sharpus brouni	X	X	X	X	19	X	X			8
Bothrideridae										
Bothriderid wv-01					0		x			1
Bothriderid wv-02					0		x			1
Brentidae										
Neocyba metrosideros		X			7	x				1
Byrrhidae										
Byrrhrid sp-02					0	X	X	x		13
Cantharidae										
Asilus sp-07					0			x		1
Asilus sp-12					0				X	2
Cantharid sp-06					0			X	X	8
Carabidae										
Carabid wv-01					0		x			1
Carabid wv-02					0			x		1
Carabid wv-03				X	36					0
Carabid wv-04					0			x		1
Neocicindela parryi	x			x	2					0
Neocicindela tuberculata	x	X	x	x	5		x			1
Cerambycidae										
Arhopalus tristus			x		1					0
Cerambycid wv-01					0			x		1

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Cerambycid wv-02				x	1					0
Coptomma sulcata					0		X	x		4
Coptomma variagatum					0		x			1
Didymocantha wv-01			X		6					0
Hybolasius modestus					0		X			7
Oemona hirta		x	X	X	5	X	X	X	X	48
Stenellipsis aegrota					0		X			6
Stenellipsis bimaculata					0				x	1
Stenellipsis fragilis					0			X	x	10
Stenellipsis gracilis					0		X			5
Stenellipsis lateus					0			x		1
Stenellipsis maculipennis					0				X	3
Stenellipsis parvula		X			5	X	x			3
Stenellipsis wv-01					0			x	X	3
Stenopotes pallidus	x				1					0
Tetrorea cilipes			x		1					0
Xylotoles gracilis			X		2		X			3
Xylotoles griseus	x			x	2					0
Xylotoles laetus					0		X			2
Cerylonidae										
Cerylonid wv-01			X		2					0
Chrysomelidae										
Alema paradoxa					0			x		1
Arnomus brouni					0			X		6
Eucolaspis brunneus					0	X		X	X	19
Eucolaspis pallidipennis		x	X	X	11			X	X	52
Eucolaspis sp-b1					0			x	x	2
Eucolaspis wv-01				X	2					0
Luperus sp-01		x			1					0
Peniticus suffusus					0		x			1
Clambidae										
Clambus domesticus		x	X		3					0
Sphaerothorax suffusus					0	X	X	x	x	6
Cleridae										
Clerid wv-02					0				x	1
Clerid wv-03		x			1					0
Clerid wv-04					0			X	X	7
Phymatophaea apicalis					0		X			2
Coccinellidae										
Adalia bipunctata		x		x	2					0
Coccinellid sp-03		x	x	x	3		x			1
Coccinellid sp-03a		x	X		3					0
Coccinellid wv-01			x	X	3					0
Coccinellid wv-02				x	1				x	1
Coccinella 11-punctata	X	x	X	X	16					0
Coccinella 9-punctata		x			1					0
Diomus notescens		X	X		46		X			2
Diomus sp-01			x		1					0
Diomus sp-16	X		X	x	12					0
Rhyzobius sp-01					0			X	X	6

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Scymnus acceptus					0				X	4
Scymnus circularis			X		2					0
Scymnus sp-02					0			x	x	2
Scymnus sp-05					0				x	1
Colydiidae										
Bitoma insularis				x	1					0
Bitoma rugosa	x			x	2	x	x			2
Colydiid sp-01		x		X	3					0
Colydiid sp-02				x	1					0
Colydiid wv-02				x	1					0
Pycnomerus sopharae	x				1		X			16
Tarphiiomimus indentatus					0	X				3
Corticariidae										
Aridius nodifer					0		x			1
Bicava sp-01	X	X	X	X	378	x	X			4
Bicava sp-02					0			X		5
Bicava sp-04				X	3	x				1
Bicava sp-09					0		x			1
Bicava sp-11				x	1			x	x	4
Bicava sp-12	X				25			X		2
Bicava sp-21					0			x		1
Bicava zelandica					0				X	3
Enicmus bifoveatus					0	x	X			3
Enicmus foveatus					0	x	X	X		9
Enicmus sp-06					0	x				1
Enicmus sp-13					0	X		X		7
Enicmus sp-22					0	X	X	X	x	13
Rethusus pustulosus					0		X			2
Corylophidae										
Arthrolips oblongus	X				2	X	X	X	X	140
Corylophid sp-06				X	9					0
Corylophid sp-07					0			x	x	2
Holopsis sp-04		X	X	X	53		X			2
Cryptophagidae										
Cryptophagid wv-01	x				1					0
Cryptophagid wv-02			x		1					0
Cryptophagid wv-03					0		x			0
Cryptophaga tasmanica					0		X			4
Micrambina Group B sp-09					0				X	18
Micrambina insignis					0	x			X	5
Micrambina sp-01			X		2	X	X	X	X	21
Curculionidae										
Ampagia rudis					0		X			4
Cossoninid sp-01					0		X			14
Cossoninid sp-04					0			X		7
Crisus binotatus					0		X		X	8
Crookacalles certus					0		X			2
Cryphalus sp-01					0		X	X		5
Curculionid wv-01		x			1		X			8
Curculionid wv-02			x		1		x			1

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Curculionid wv-03		x	x		2					0
Curculionid wv-04					0		x			1
Curculionid wv-05					0		x			1
Curculionid wv-06					0		X			2
Curculionid wv-07					0			x		1
Curculionid wv-08			x		1					0
Euophryum confine					0		x			1
Euprocas wv-01					0			x		1
Irenimus compressus					0	X				4
Mecistostylus douei					0		x			1
Microcryptorhynchus spp	x	x			2	X	X	X	X	25
Notocalles spp					0	x				1
Pactola variabilis					0		x			1
Phloeophagosoma thoracicum		x			1	X		x		5
Pogonorhinus opacus					0			x		1
Praolepra infusca					0	X				9
Psepholax sulcatus					0		x	x		2
Rhabdinosomus acuminatus		x		x	2					0
Rhopalomerus demanensis					0	X		x		3
Rhopalomerus fasciatus					0		X			2
Rhopalomerus maurus					0		X		x	3
Rhopalomerus tennuicornis					0	x				1
Rhopalomerus wv-01					0		x			1
Rhopalomerus wv-02					0		x			1
Scolytinid wv-01					0		X			2
Sitona discoideus	X	X	X	X	1009		X	X	X	22
Sitona sp-01			x		1					0
Stephanorhynchus curvipes					0		x			1
Sympedius testudo					0		X			6
Tysius bicornis					0		X			4
Xyleborinus compressus	X			X	6					0
Dermestidae										
Anthrenus australis			x		1					0
Anthrenus verbasci			x		1					0
Dermestid wv-01					0			X		3
Elateridae										
Aglophus modestus					0				x	1
Aglophus wv-01					0			X		2
Agrypnus variabilis				X	3					0
Betarmoides wv-01					0			x	x	2
Conoderus exsul	X	X	X	X	416	X	X	x	X	14
Conoderus sp-01		X	X		23					0
Conoderus sp-02			X		3					0
Ctenicera wv-01					0			X	X	30
Ctenicera wv-02				x	1				X	16
Ctenicera wv-03					0			x		1
Ctenicera wv-05					0				x	1
Elaterid wv-01				x	1			x		1
Elaterid wv-02		x			1		X			3
Elaterid wv-03					0	X	X			7
Elaterid wv-04					0		X			3

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Elaterid wv-05					0		x			1
Lomemus pilicornis					0	x	X			3
Lomemus sp-02	x				1	x	X		x	6
Lomemus wv-01					0	X	x		x	7
Mecastrus discedens					0		X			5
Metablax acutipennis					0		x		x	2
Oxylasma wv-01					0			x	x	2
Panspoeus guttatus					0	X	X		X	82
Parablax cinctiger					0	X		X		6
Protelater elongatus					0		x	x		2
Protelater guttatus					0		X			2
Protelater opacus					0		X		X	8
Sphaenelater linicollis					0		x			1
Thoramus perblandus					0	X				3
Thoramus wv-01	X				2					0
Eucnemidae										
Eucnemid wv-01	x		x	x	3				X	2
Eucnemid wv-02					0		x			1
Eucnemid wv-03					0	X	X			4
Hydrophilidae										
Adolopus sp-02			X		3					0
Hydrophilid sp-02			X		2					0
Languriidae										
Hapalips prolixus					0			X	x	3
Leiodidae										
Colon hirtale					0		X	x	X	7
Leiodid sp-12					0		X	X		5
Leiodid wv-01				x	1					0
Leiodid wv-03					0		x			1
Leiodid wv-07					0			X		3
Mesocolon sp-01					0		X	X		7
Mesocolon sp-03					0			x		1
Paracotops phyllobius					0	x	X	X		20
Lycidae										
Porrostoma rufipennis					0		x			1
Melandryidae										
Allopterus ornatus					0	x	X	X	x	11
Allopterus sp-04					0		x			1
Axylita sp-01					0		X			2
Hylobia nubeculosa					0		x			1
Hylobia sp-02					0				X	2
Melandryid wv-01					0		X			2
Melyridae										
Dasytes sp-01		x	x		2					0
Melyrid sp-13					0				x	1
Mordellidae										
Mordellid sp-01	X	X	X	X	22	X	X	x	X	13
Mordellid sp-02					0		X	x	x	18
Mordellid wv-01	X	x	X	x	8					0
Mordellid wv-02			X	X	10		X	x		19
Mordella detracta					0		X	x		4

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Mordellistena neglecta					0	X	X	X	X	24
Mycetophagidae										
Mycetophagid sp-03					0	x		x	x	3
Mycetophagid wv-01			X		57					0
Mycetophagid wv-03		x		x	2	x		x	x	3
Nitidulidae										
Epuraea zelandica					0			x		1
Nitidulid wv-01					0		x			1
Nosodendridae										
Nosodendron zelandicus		x		x	2					0
Oedemeridae										
Baculipalpus strigipennis	x			x	2					0
Thelyphassa lineata				X	5					0
Phalacridae										
Phalacrus nr *festiva*			X		3					0
Prostomidae										
Prostomatid wv-01			x		1					0
Ptilidae										
Ptilid sp-01			X		2					0
Salpingidae										
Salpingus bilunatus				x	1	X	X	X	X	83
Salpingus perpunctatus		x		X	4		X			6
Salpingus sp-08	x			X	8					0
Salpingid wv-01			x		1					0
Salpingid wv-05					0				x	1
Scarabaeidae										
Costelytra austrobranengiven					0			x		1
Costelytra zelandica			X		6				x	1
Odontria sp-08					0	X	x	x	x	6
Odontria sylvatica	X				11					0
Odontria wv-01	X				2	X				2
Odontria wv-02	x	X			8	X				15
Odontria xanthosticta					0	X	X			24
Pyronota festiva	x	x	X	x	6	X			X	7
Scirtidae										
Cyphon wv-01	x				1		X			3
Cyphon wv-02			x		1		X			17
Cyphon wv-04					0	x			X	3
Cyphon wv-05			x		1		x			1
Cyphon wv-06					0			x		1
Cyphon wv-07				x	1					0
Scirtid sp-12					0				x	1
Scirtid wv-01					0		X			6
Scirtid wv-02	x	x		X	14					0
Scirtid wv-03			X		3					0
Scirtid wv-04			x	X	4			X	X	5
Scirtid wv-11c					0			x	x	2
Scraptiidae										
Nothotelus nigellus					0				x	1
Silvanidae										
Cryptomorpha brevicornis					0		X			2

	Sand Dunes / Grass Areas					Forest Setting				
Study Site	1	2	3	4	#	5	6	7	8	#
Cryptomorpha sp-01		X	X		10					0
Staphylinidae										
Atheta sp-39					0				x	1
Brachyglutini sp-10					0			x		1
Brouniella sp-09		x			1		X			2
Creophilus oculatus		x	X		3					0
Gyrophaena wv-01					0			x		1
Ischnoderus wv-01				x	1		x			1
Oclea socialis					0		x			1
Ocalea sp-01					0	X	x	x	X	6
Oxypodinid sp-08					0			x		1
Philonthes sp-01				X	11					0
Pselaphinid sp-20				x	1					0
Pselaphinid wv-01					0			x		1
Scaphidiinid sp-01					0	x	X			4
Sepedophilus acerbus					0			X	x	3
Sepedophilus auricomis			x	x	2	X	X	X	x	10
Sepedophilus flavithorax				x	1		x	x		2
Sepedophilus maculosus		X			3					0
Sepedophilus wv-01					0		x			1
Sepedophilus wv-02					0		x			1
Sepedophilus wv-03					0	x				1
Sepedophilus wv-04		X			3					0
Staphylinid wv-01			x		1					0
Staphylinid wv-02			x		1					0
Staphylinid wv-03					0			x		1
Staphylinid wv-04			X		3					0
Staphylinid wv-05			X		4					0
Staphylinid wv-06			X		9					0
Staphylinid wv-07			X		7					0
Staphylinid wv-08			x		1					0
Staphylinid wv-09			x		1					0
Staphylinid wv-10			x		1					0
Staphylinid wv-11		X			3					0
Staphylinid wv-12					0		x			1
Staphylinid wv-13					0		x			1
Tramiathea sp-02		X		X	7					0
Tramiathea sp-02b					0	x				1
Tramiathea sp-02c				X	14		x		X	9
Xantholinid sp-01			X	X	20		x	x		2
Xantholinid wv-01			X		8					0
Xantholinid wv-02			X		2					0
Xantholinid wv-03				x	1					0
Tenebrionidae										
Tanychilus sophorae					0		x		X	4
Trogossitidae										
Rentoniinid sp-01	x			x	2	X				3